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COP27 CLIMATE CHANGE CONFERENCE: URGENT ACTION NEEDED FOR AFRICA AND THE WORLD

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Wealthy nations must step up support for Africa and vulnerable countries in addressing past, present and future impacts of climate change

The 2022 report of the Intergovernmental Panel on Climate Change (IPCC) paints a dark picture of the future of life on earth, characterised by ecosystem collapse, species extinction, and climate hazards such as heatwaves and floods (1). These are all linked to physical and mental health problems, with direct and indirect consequences of increased morbidity and mortality. To avoid these catastrophic health effects across all regions of the globe, there is broad agreement—as 231 health journals argued together in 2021—that the rise in global temperature must be limited to less than 1.5^{o}C compared with pre-industrial levels.

While the Paris Agreement of 2015 outlines a global action framework that incorporates providing climate finance to developing countries, this support has yet to materialise (2). COP27 is the fifth Conference of the Parties (COP) to be organised in Africa since its inception in 1995. Ahead of this meeting, we—as health journal editors from across the continent—call for urgent action to ensure it is the COP that finally delivers climate justice for Africa and vulnerable countries. This is essential not just for the health of those countries, but for the health of the whole world.

Africa has suffered disproportionately although it has done little to cause the crisis

The climate crisis has had an impact on the environmental and social determinants of health across Africa, leading to devastating health effects (3). Impacts on health can result directly from environmental shocks and indirectly through socially mediated effects (4). Climate change-related risks in Africa include flooding, drought, heatwaves, reduced food production, and reduced labour productivity (5).

Droughts in sub-Saharan Africa have tripled between 1970-79 and 2010-2019 (6). In 2018, devastating cyclones impacted 2.2 million people in Malawi, Mozambique and Zimbabwe (6). In west and central Africa, severe flooding resulted in mortality and forced migration from loss of shelter, cultivated land, and livestock (7). Changes in vector ecology brought about by floods and damage to environmental hygiene have led to increases in diseases across sub-Saharan Africa, with rises in malaria, dengue fever, Lassa fever, Rift Valley fever, Lyme disease, Ebola virus, West Nile virus and other infections (8, 9). Rising sea levels reduce water quality, leading to water-borne diseases, including diarrhoeal diseases, a leading cause of mortality in Africa (8). Extreme weather damages water and food supply, increasing food insecurity and malnutrition, which causes 1.7 million deaths annually in Africa (10). According to the Food and Agriculture Organization of the United Nations, malnutrition has increased by almost 50% since 2012, owing to the central role agriculture plays in African economies (11). Environmental shocks and their knock-on effects also cause severe harm to mental health (12). In all, it is estimated that the climate crisis has destroyed a fifth of the gross domestic product (GDP) of the countries most vulnerable to climate shocks (13).

The damage to Africa should be of supreme concern to all nations. This is partly for moral reasons. It is highly unjust that the most impacted nations have contributed the least to global cumulative emissions, which are driving the climate crisis and its increasingly severe effects. North America and Europe have contributed 62% of carbon dioxide emissions since the Industrial Revolution, whereas Africa has contributed only 3% (14).

The fight against the climate crisis needs all hands on deck

Yet it is not just for moral reasons that all nations should be concerned for Africa. The acute and chronic impacts of the climate crisis create problems like poverty, infectious disease, forced migration, and conflict that spread through globalised systems (6, 15). These knock-on impacts affect all nations. COVID-19 served as a wake-up call to these global dynamics and it is no coincidence that health professionals have been active in identifying and responding to the consequences of growing systemic risks to health. But the lessons of the COVID-19 pandemic should not be limited to pandemic risk (16, 17). Instead, it is imperative that the suffering of frontline nations, including those in Africa, be the core consideration at COP27: in an interconnected world, leaving countries to the mercy of environmental shocks creates instability that has severe consequences for all nations.

The primary focus of climate summits remains to rapidly reduce emissions so that global temperature rises are kept to below 1.5 °C. This will limit the harm. But, for Africa and other vulnerable regions, this harm is already severe. Achieving the promised target of providing $100bn of climate finance a year is now globally critical if we are to forestall the systemic risks of leaving societies in crisis. This can be done by ensuring these resources focus on increasing resilience to the existing and inevitable future impacts of the climate crisis, as well as on supporting vulnerable nations to reduce their greenhouse gas emissions: a parity of esteem between adaptation and mitigation. These resources should come through grants not loans, and be urgently scaled up before the current review period of 2025. They must put health system resilience at the forefront, as the compounding crises caused by the climate crisis often manifest in acute health problems. Financing adaptation will be more cost-effective than relying on disaster relief.

Some progress has been made on adaptation in Africa and around the world, including early warning systems and infrastructure to defend against extremes. But frontline nations are not compensated for impacts from a crisis they did not cause. This is not only unfair, but also drives the spiral of global destabilisation, as nations pour money into responding to disasters, but can no longer afford to pay for greater resilience or to reduce the root problem through emissions reductions. A financing facility for loss and damage must now be introduced, providing additional resources beyond those given for mitigation and adaptation. This must go beyond the failures of COP26 where the suggestion of such a facility was downgraded to “a dialogue” (18).

The climate crisis is a product of global inaction, and comes at great cost not only to disproportionately impacted African countries, but to the whole world. Africa is united with other frontline regions in urging wealthy nations to finally step up, if for no other reason than that the crises in Africa will sooner rather than later spread and engulf all corners of the globe, by which time it may be too late to effectively respond. If so far they have failed to be persuaded by moral arguments, then hopefully their self-interest will now prevail.

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RADIOGRAPHIC DETERMINATION OF NORMAL RANGE VALUES OF ACROMIOCLAVICULAR JOINT SPACE IN NIGERIAN POPULATION

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ABSTRACT

Background: Acromioclavicular joint space is one of the most common injuries of the shoulder region. Accurate diagnosis of most acromioclavicular (AC) joint pathologies depends on the knowledge of the normal range values of acromioclavicular joint space. The variation in the normal AC joint spaces among the studied population points to the need to have population-specific reference range values of acromioclavicular joint space while the paucity of data on normal acromioclavicular joint space diameter in our locality necessitated this study.

Objective: This study was, therefore, aimed at radiographically determining the normal reference range values of acromioclavicular joint space diameter with age in adult Nigerian and also to find its variation with sex.

Methods: This retrospective study was conducted in three tertiary hospitals in Enugu from January 2019 to July 2019. It involved digital anteroposterior shoulder radiographs of 628 adults (18 – 80 years) obtained using Zanca's view and reported as normal by four consultant radiologists. The acromioclavicular joint space diameter is calculated as an integral of the distances between the superior and inferior borders of the acromioclavicular joint space. Data were analyzed using a linear regression model, Pearson product-moment correlation coefficient, and independent sample t-test.

Results: The mean AC joint space diameter ranged from 3.63 mm at ≤ 20 years to 1.14 mm at 76-80 years of age. Acromioclavicular joint space diameter correlated strongly but negatively with age with correlation coefficients of -0.785, -.839, -.797, and -.780. There was a significant difference between the acromioclavicular joint space diameter of males and females ($p = 0.000$).

Conclusion: This study has generated a reference range value of normal acromioclavicular joint space diameter with age in our locality while there is a difference in acromioclavicular joint space between male and female adult Nigerians.

Keywords: Radiographic determination, acromioclavicular joint space, adult Nigeria

Introduction

The acromioclavicular (AC) joint is a diarthrodial joint of the shoulder region which is formed by the lateral end of the clavicle and the medial end of the acromion of the scapula and links the upper extremity to the axial skeleton [1]. The AC joint is superficial in position with its integrity being maintained by acromioclavicular and coracoclavicular ligaments [2]. Due to its diarthrodial nature and superficial position, the AC joint is affected by many pathological processes, including joint separation, osteoarthritis, trauma, post-traumatic arthritis, and distal clavicular osteolysis [3]. These disease processes disrupt the normal anatomy and physiology of the AC joint space diameter leading to pain as the most common symptom. Separation of the acromioclavicular joint remains the most common occurring shoulder injury [4] while asymptomatic joint degeneration is also frequent [3]. Disruption of the AC joint space diameter was found to account for approximately 12% of dislocations involving the shoulder joint and 10% of all shoulder injuries while these injuries occur about five times more frequently in the male population [5]. It is also important to note that degeneration of the acromioclavicular joint space is a natural phenomenon associated with age as disc degeneration can occur as early as the second decade of life [6, 7].

These disease processes can be diagnosed through history taking, physical examination, and imaging. History taking and physical examinations are mainly subjective [8] and any suspicion of acromioclavicular joint injury will require imaging for objective assessment. conventional X-ray examination, computed tomography (CT), and magnetic Resonance Imaging (MRI) are imaging modalities used in the assessment of AC joints. Computed Tomography gives an excellent visualization of the articular surfaces, osseous changes, and subtle or complex fracture and joint mal-alignment coupled with speedy scan time. However, the high cost of CT examination coupled with the high radiation dose to patients made it not justifiable to be used for examinations involving no obvious pathology [9]. Magnetic resonance imaging with its multi-planar capabilities and superior soft tissue resolution gives a high-quality image of AC joint but its relatively high cost and limited availability in the locality make conventional X-ray imaging the preferred first-line imaging modality for the diagnosis of AC joint injuries and pathologies. Conventional X-ray examination of the AC joint is carried out using standard views such as the anteroposterior view (AP), and lateral and axial views of the shoulder although the Zanca view is the best view for imaging the AC joint space [10].

The configuration of AC joint space diameter has been found to vary significantly in studied populations while the craniocaudal (CC) interspace diameter also exhibits considerable variability [10]. Several studies [11, 12, 13] done on radiographic assessment of AC joint space diameter were carried out on the Caucasian population. There is a paucity of data on our local population's radiographic assessment of the AC joint space. Given these revelations from the reviewed pieces of literature, there is a need for this study to provide the necessary data for the locality. This study is therefore aimed at radiographically generating a range of reference values of acromioclavicular joint space diameter according to age and sex and comparing right and left acromioclavicular joint space in both male and female adult Nigerians with normal shoulders. The range of reference values generated will serve as an indigenous value of normal acromioclavicular joint space while its usage in our locality will eliminate errors from possible racial differences when values from Caucasians are used.

Methods:

This retrospective study was conducted in three tertiary hospitals in the Enugu metropolis from January 2019 to July 2019 and involved 628 shoulder radiographs obtained using the Zanca view as described by Li et al, [14]. Included in this study were anteroposterior shoulder radiographs reported as normal and having no evidence of rotation. This study excludes AP radiographs taken in Zanca view but has no radiologist report or missing data in the result. The reporting of the radiographs was done by four Consultant Radiologists in Enugu State, Nigeria. These institutions were selected because they include the Zanca view as part of departmental routine views for shoulder x-ray and also use the same model of the *i*CRco digitizer. Before the actual measurement of the AC joint space diameter, a pilot study was conducted on ten AP shoulder radiographs obtained using the Zanca view by two

Radiographers with more than 10 years of experience in radiography to determine the intra- and inter-observer reliability in the measurement after which one radiographer obtained the rest of the measurements. The upper width (cranial diameter) and the lower width (caudal diameter) were measured three times using an inbuilt electronic caliper in the *i*CRco digitizer PC workstation and their averages were taken. The acromioclavicular joint space diameter was then calculated as an integral value of both the cranial and caudal diameters of the AC joint space **(Figure I**). The patients' demographic data such as age and sex were also recorded. Ethical clearance with Ref. No: CON/MHPHD/1866/94 was obtained from the State Ministry of Health while consent was obtained from the management of the hospitals before the study commenced. The data were deposited in the repository with DOI: 10.17632/d96j4psvdt.1**.**

Data Analysis:

The reliability of acromioclavicular joint space diameter measurement within and between two radiographers was assessed using intraclass and interclass coefficient ICC and a two-way random effect model, assuming a single measurement and absolute agreement. The changes in AC joint space diameter with age was determined using the linear regression model while an independent sample t-test was used to test for significant difference between right and left AC joint space diameter in males and females. The relationship between acromioclavicular joint space diameter and age was determined using the Pearson product-moment correlation coefficient.

Results:

The study comprised 628 shoulder radiographs with 308 (49.0%) females and 320 (51.0%) males. Out of the 308 female radiographs, 145 (47%) were right shoulders while 163 (53%) were left shoulders. Also, of 320 male radiographs, 204(64%) were right shoulder radiographs while 116(36%) were left shoulder radiographs. The mean age of the studied subjects is 43.73 ± 15.56 years with the age range of 29-33 years having the highest frequency while the age range of 64 – 68 years has the least frequency.

Measurement of AC joint space diameter showed excellent agreement within and between radiographers with intra-class correlation coefficient ICC (3,1) of 0.925 while the inter-class correlation coefficient ICC (3,1) is 0.847 **(Table 1)**.

The changes in mean AC joint spaces diameter with age were determined using a linear regression model which generated the regression equation as follows:

$$\text{Mean AC joint space (MACJ)} = 0.675 - 0.05 \times Age$$

From our study, the mean AC joint space decreases with an increase in age. The male ACJ space diameter decreases from 3.62 mm at ≤ 20 years to 1.14 mm at 76-80 years while the female ACJ space diameter decreases from 3.63 mm at ≤ 20 years to 1.14 mm at 76-80 years of age **(Table 2).** The right ACJ decreases from 3.68 mm at ≤ 20 years to 1.14 mm at 76-80 years of age while the left ACJ decreases from 3.55 mm at ≤ 20 years to 1.14mm at 76-80 years of age **(Table 3)**. The Pearson correlation coefficient determined the relationship between acromioclavicular joint space with age. Our study indicated that the mean right male and female AC joint space diameters show a strong negative correlation with age with a correlation coefficient of -.839 and -.785 respectively. In the same manner, mean left male and female AC joint space diameters show a strong negative correlation with age with Pearson correlation coefficients of -.780 and -.797 respectively **(Table 4)**.

The mean right AC joint space diameter for males was compared to females' mean right AC joint space diameter using the independent sample t-test at a significant level of 0.05. The result shows a statistically significant difference between them with a p-value of 0.000. Also, the mean left AC joint space diameter of males was compared to that of the female at 0.05 level of significance, the result shows a statistically significant difference between the two sexes with a p-value of 0.027.

Table 1: Intraclass correlation Coefficient of Acromioclavicular joint space measurement

Intraclass Correlation		95% confidence interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
			Inter rater				
Single measures		0.729	0.981	25.636	9	9	0.000
Average measures	0.961	0.843	0.990	25.636	9	9	0.000
			Intra rater				
Single Measures	0.847	0.499	0.960	12.039	9	9	0.001
Average measures	0.917	0.666	0.979	12.039	9	9	0.001

Table 2: Mean Male and Female Acromioclavicular Joint Space Diameters with Age

	MALES			FEMALES		
Age (years)	**Freq**	**Mean ± SD**	**Range (mm)**	**Freq**	**Mean ± SD**	**Range (mm)**
≤ 20	11	3.62±0.28	3.15-4.15	17	3.63±0.33	3.13-4.16
21-25	31	3.24±0.37	2.57-3.82	33	3.26±0.38	2.57-3.80
26-30	32	3.21±0,39	2.46-4.00	32	3.24±0.39	2.48-3.98
31-35	40	3.09±0.38	2.60-3.68	40	3.09±0.38	2.61-0.38
36-40	29	2.87±0.32	2.49-0.32	26	2.90±0.34	2.48-3.65
41-45	34	2.66±0,45	1.90-3.30	23	2.67±0.48	1.92-3.27
46-50	34	2.49±0.42	1.60-3.22	30	2.48±0.44	1.63-3.23
51-55	28	2.38±0.30	1.81-2.92	28	2.39±0.36	1.67-2.91
56-60	27	2.35±0.36	1.87-3.01	29	2.29±0.43	1.63-3.04
61-65	11	2.09±0.29	1.50-2.65	19	2.04±0.23	1.52-2.62
66-70	20	1.93±0.36	1.46-2.58	20	1.96±0.25	1.55-2.25
71-75	9	1.71±0.18	1.55-2.08	7	1.66±0.18	1.54-2.04
76-80	4	1.14±0.02	1.12-1.12	4	1.14±0.00	1.14-1.16
TOTAL	**320**			**308**		

Table 3: Mean Right and Left Acromioclavicular Joint Space Diameters with Age

Age (years)	Freq	Right ACJ Mean ± SD (mm)	Range (mm)	Freq	Left ACJ Mean ± SD (mm)	Range (mm)
≤ 20	17	3.68±0.31	3.15-4.16	11	3.55-0.31	3.13-4.16
21-25	33	3.28±0.39	2.57-3.82	31	3.23-0.39	2.57-3.82
26-30	32	3.25±0.44	2.46-4	32	3.2-0.44	2.48-4
31-35	51	3.13±0.38	2.6-3.68	29	3.04-0.38	2.61-3.68
36-40	37	2.88±0.33	2.49-3.61	18	2.89-0.33	2.48-3.61
41-45	40	2.62±0.44	1.9-3.3	17	2.78-0.44	1.93-3.3
46-50	35	2.48±0.35	1.6-3.22	29	2.5-0.35	1.6-3.22
51-55	18	2.33±0.36	1.67-2.86	38	2.4-0.36	1.81-2.86
56-60	38	2.32±0.43	1.63-3.04	18	2.37-0.43	1.88-2.88
61-65	18	2.00±0.27	1.5-2.62	22	2.12-0.27	1.52-2.68
66-70	15	1.87±0.28	1.46-2.34	25	2.05-0.28	1.03-2.58
71-75	10	1.78±0.18	1.54-2.04	6	1.96-0.18	1.86-2.08
76-80	5	1.14±0.01	1.13-1.16	3	1.14-0.01	1.12-1.18
	349			**279**		

Table 4: Table 4: Pearson Product Moment Correlation Coefficient of the Mean ACJ and Age

	Pearson Correlation	Sig. (2-tailed)	N
Rt ACJ Female	-0.785**	0.000	204
Rt ACJ Male	-0.839**	0.000	145
Lt ACJ Female	-0.797**	0.000	116
Lt ACJ Male	-0.780	0.000	163

** Correlation is significant at the 0.01 level (2-tailed).

Discussion:

One of the common sources of pain in the body is the shoulder joint. Chronic shoulder pain is a common condition in Nigeria [15], and the incidence of shoulder pain in adults was between 15% and 30% [16]. Also, research has proven that yearly, about 50% of the population will present to a hospital with at least an episode of shoulder pain syndrome [17]. Most causes of shoulder pain are associated with a decrease or widening of the AC joint space diameter [18, 19] which implies that accurate diagnosis of these diseases depends on knowing how the AC joint space diameter deviates from the normal values. Petersson and Redlund [19] also stated that widening of the AC joint space greater than 7mm in males and 6 mm in the female when compared to the normal value is pathological irrespective of the age of the patient. Accurate diagnosis of these pathologies of the acromioclavicular joint space depends largely on the knowledge of the population-specific normal reference range values as Lee et al [20] noted potential differences in average skeletal size between Asian and Western populations. They further opined that the absolute measurement of acromioclavicular joint space of the Asian population will differ from the values in the Western population.

In our study, measurement of AC joint space diameter has been found to show high ICC (3,1) and excellent agreement within and between measurements which goes to show that ACJ space diameter measurement is highly reliable and reproducible (ICC = 0.925 and 0.847, p-value = 0.000 and 0.001 for within and between measurement respectively). This is in line with the findings of Zumstein et al [21] who noted excellent intra- and interobserver reliability in acromioclavicular joint dislocation measurement. Also, Gastaud et al [22] found good to excellent intra- and inter- on the anteroposterior measurement of acromioclavicular joint separation.

Mean AC joint space diameter was found to decrease with age in both females and males. This decrease in AC joint space diameter with age can be attributed to the gradual degeneration of the joint cartilage which occurs as part of the aging process [6]. This finding is in line with similar work done by Zanca [23] who found that the limit of AC joint space diameter in a healthy adult shoulder varies between 1mm and 3 mm. Guillotin et al [24] noted that the incidence of radiological changes in the ACJ increases with age and that degenerative change accounts for 68% in patients below 30 years and 93% in patients above 30 years. Also, similar works [7, 19, 20, 25] on the AC joint space diameter have found a decrease in the joint space with age in both males and females.

The right and left ACJ space diameters in males were compared to that of the females and the results show a statistically significant difference with male ACJ being higher than the female (p = 0.024). Also, there is a statistically significant difference between the left ACJ in both males and females with the males being higher than the females (p = 0.000). This is in line with the study by Petersson and Redlund [19] which was conducted in Sweden and noted a significant difference in the AC joint space diameter between males and females with males being wider than females. Our finding could be explained by the fact that men are usually involved in hard manual work which results in an increased rate of tears and wears in their acromioclavicular joint spaces when compared to that of the female.

Both right and left ACJ in both sexes' correlate strongly although negatively with age. Male and female right ACJ has a correlation coefficient of -.785 and -.839 respectively while the male and female left ACJ has a correlation coefficient of -.797 and -.780 respectively. This finding is in line with several studies [7,19, 20] which show a negative correlation between acromioclavicular joint space with age. These could be attributed to degenerative changes occurring as age increases.

Conclusion

Acromioclavicular joint space diameter in normal Nigerians decreases with an increase in age while no statistical difference in acromioclavicular joint space exists between males and females.

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KNOWLEDGE AND PRACTICE OF IMAGING OF CHILDREN WITH SUSPECTED CASES OF NON-ACCIDENTAL INJURIES AMONG RADIOGRAPHERS WITHIN MAIDUGURI METROPOLIS, NORTHEASTERN NIGERIA

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ABSTRACT

Objectives: To assess the knowledge and practice of Non-accidental injuries (NAI) among radiographers practicing within Maiduguri Metropolis.
Methods: A cross-sectional study was conducted using a questionnaire to elicit information on knowledge and practice of imaging children with Non-accidental injuries. The information elicited from the questionnaire related to the following themes: Demographic characteristics, knowledge and practice of imaging children with NAI. Informed consent was sought from participants. Descriptive statistics (mean, frequencies) were used to analyze the data.
Results: A total of 45 questionnaires were distributed to radiographers, and 36 (100%) were completed and returned. A total of 23 (63.9%) were males and 13 (36.1%) were females. The majority 34 (94.4%) of the respondents had good knowledge of NAI. Skeletal survey was the examination commonly requested in children with NAI as reported by 23 (63.9%) respondents, and the majority of the participants 31 (86.1%) had no specialty training in pediatric imaging. A total of 23 (63.9%) participants knew that using a single film to image the whole body (baby-gram) was an obsolete examination.
Conclusion: Radiographers in this study have good knowledge of NAI in children and are involved in imaging children with suspected cases of non-accidental injury. It is evident from the results of this study that NAI among children occurs in our environment and a majority of these cases are underreported and may even go unnoticed. Having adequate knowledge of clinical and radiologic manifestations of NAI in children will enable the radiographer to deliver evidence-based practice in line with international best practices.
Keywords: Non-accidental injury (NAI), Child abuse, Radiographers.

Introduction

Non-accidental injury (NAI) in children or physical child abuse also referred to as battered child syndrome, shaken baby syndrome, or non-accidental trauma (NAT) has been recognized as a major public health burden impacting the health and welfare of children and adolescents and remains one of the leading causes of morbidity and mortality in children worldwide (1-3). According to the United Nations Convention on Child Rights Act, 2003, a child is anyone who has not attained 18 years (4,5). Child abuse is 'any kind of physical, sexual, emotional abuse, neglect or negligent treatment, commercial or other exploitation resulting in actual or potential harm to the child's health, survival, development, or dignity in the context of a relationship of responsibility, trust or power (1,6).

Nigerian society is still plagued with incidences of child labour, child maltreatment, child trafficking and neglect. In recent times, there have been increased reports of kidnappings, forced labour and forced marriages (1). Growing evidence suggests that in addition to the immediate negative effects of maltreatment on children, there are associated host of problems that are manifested in adolescence and adulthood (6,7). Radiographers among other healthcare professionals, perform a critical role in the care, assessment and radiological management of NAI in children. They play an integral role in preserving the catalogue of evidence in proven cases of abuse (8). Radiological investigations are essential when assessing children who may have been subjected to physical abuse (9). Imaging in NAI has however remained a debated issue with little agreement on how, when and what type of imaging modalities should be used in the investigation of suspected cases of NAI (9). Investigating NAI requires thorough history taking and adequate clinical examination, which are usually supplemented with radiological investigations, including plain radiographic and cross-sectional imaging (3). It is noteworthy that most of the history provided would often be incomplete or misleading, especially from the parents, guardians and even caregivers, and physical examination alone may not reveal occult injuries, the knowledge of radiographers about NAI will play a vital role in identifying and diagnosing NAI in children even when it is concealed (10). Failure to diagnose NAI carries a great risk of morbidity and mortality, particularly in children who are non-ambulatory and non-verbal yet (3).

In the past few decades, technological advances have propelled a significant increase in the radiological arsenal, consequently, the availability of hitherto not available; conventional radiography, Ultrasonography, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) among others are now available most developing countries including Nigeria (11). Computed tomography is widely being used as first-line trauma triage, this is not unconnected to the fact that it has an edge over plain film or conventional radiography by providing 3-D imaging capabilities, and cross-sectional images thus avoiding superimposition which is a major drawback in conventional radiography. However, given the relatively high radiation dose involved in CT, it should not totally replace conventional radiography. In situations where a CT scan is performed during trauma evaluation, the full skeletal survey should still be performed (11). Ultrasonography is also widely used as an extension of the physical examination and as an adjunct to, not replacement or sole modality for conventional imaging methods of skeletal trauma in cases of suspected physical abuse (10). The radiographic skeletal survey is the principal radiological investigation of suspected child abuse, and it is commonly presented as evidence in child protection cases, criminal proceedings and other types of litigation (10). Fractures are reported to be the second most common finding in child abuse, after skin lesions such as bruises and contusions (5,12). Fractures can occur in any part of the skeletal system and they are high chances of being multiple with different spectrums of findings (10,12). Conventional radiography has historically been and, to date continues to be the mainstay in radiological imaging of suspected child abuse. It aids in identifying new cases of possible child abuse, where an incidental finding on a radiograph may be the first sign of child abuse and in the workup of suspected child abuse cases. Thus, having a good knowledge of NAI injuries and their common presentations and symptoms by radiographers will not only inform their practice but will also help in identification and possibly communicate the same to the reporting radiologist who may not have the opportunity of interacting with the patient during imaging investigation (10,12).

Methods:

This was an explorative cross-sectional study that investigated the knowledge and practice of imaging children with Non-accidental injuries among Radiographers. Ethical approval was obtained from the institutions involved in the study and informed consent was obtained from all the participants and participation was voluntary. A 28-item semi-structured questionnaire was used to collect data. The questionnaire consisted of participants' demographic characteristics, the knowledge of imaging children with non-accidental injuries (NAI), and the practice of imaging children with NAI. The questionnaires contained questions related to knowledge and practice of imaging children with NAI. The participants indicated their level of agreement with the statements using a four-item Likert scale ranging from (4= ‘strongly disagree’, 3= ‘disagree’, 2= ‘agree’, 1= ‘strongly agree’). The questionnaire was adopted from (13-17) and adapted to suit the study's objectives, pilot-tested and with a Cronbach alpha value of 0.82. The data collected were analyzed using descriptive statistics using the statistical package for social sciences (SPSS) version 18.0.

Results

A total of 100% (36) responses were received from the radiographers. Of these, 63.9% (23) were males and 36.1% (13) were females. The largest age group with 80.6% (29) was the group from 24 to 34 years, and a good majority 80.1% (29) had a first degree as their educational qualification, while 63.9% (23) of respondents had greater than three years of work experience. Participants were from three hospitals: labeled A, B, and C for anonymity, as shown in Table 1.

The majority of 94.4% (34) participants had good knowledge of NAI and were also involved in imaging children brought for radiologic examinations and a total of 36.1% (13) agreed that pediatric imaging is a recognized sub-specialty in their department. A total of 63.9% (23) agreed that skeletal survey was the standard protocol for imaging children in their department, and a total of 77.7% (28) of the respondents disagreed that there is no need to sub-specialize in pediatric imaging as every radiographer should be able to demonstrate requested projections. About 63.9% (23) were also against using a single film to image the whole body of a child for economic purposes and to avoid multiple exposures to radiation. Conventional radiography (plain X-rays) 63.9% (23) and ultrasound 22.2% (8) were the commonest imaging modalities used to image children presenting with NAI in this study, as seen in table 2.

A total of 61.1% (22) of the respondents claimed that skeletal survey is the examination commonly requested in children with NAI and 13.9% (3) were of the opinion that skull radiography is the most commonly requested examination in children with NAI. Also, 55.6% (20) of the respondents suggest that bone is the common organ of interest and 2.8% (1) go for other specifications. The majority of the respondents, 58.3% (21) claimed that fractures are the most common findings and 2.8% (1) suggest that lung infections are the most common. About 52.8% (19) of respondents believed lateral projections best demonstrate fractures of the spines. Also, 38.8% (14) respondents believed AP projections best demonstrates fracture of the appendicular skeleton. A good number of the respondents 52.7% (19) claimed that PA and the lateral projections best demonstrates fracture of the skull. The respondents identified the culture and traditions of the people 25% (9), unwillingness and lack of cooperation from the healthcare team 16.7% (6), lack of strong legislation against perpetrators 16.7% (6), lack of functional social care service 13.9% (5), and the lack of dedicated pediatric facility and immobilization devices, as the major challenge to imaging children with suspected cases of NAI, as shown in Table 3.

Table 1: Demographic Characteristics of the Participants

Hospital	Frequency	Percentage (%)
Number of Children attended to per week		
Center A	23	63.9
Center B	7	19.6
Center C	6	16.6
Total	36	100
Gender		
Male	23	63.9
Female	13	36.1
Total	36	100
Age		
18-24	2	5.6
25-34	29	80.6
35-44	3	8.3
45 & above	2	5.6
Total	36	100
Marital Status		
Single	18	50
Married	16	44.4
Divorced	1	2.8
Others	1	2.8
Total	36	100
Educational Qualification		
Diploma	1	2.8
Bachelor's Degree	29	80.1
Master's Degree	4	11.1
Doctor of Philosophy	2	5.6
Total	36	100
Present Post?		
Intern Radiographer	13	36
Senior Radiographer	17	47.2
Principal Radiographer	4	11.2
Chief Radiographer	2	5.6
Total	36	100
Years of working experience?		
0-2 years	13	36.1
3-5 years	14	38.9
6-8 years	2	5.6
9-11 years	3	8.3
12 years & above	4	11.1
Total	36	100

Table 2: Knowledge of Imaging Children with Non-Accidental Injury (NAI)

Items	Frequency	Percentages
Do you Know What NAI is?		
Yes	34	94.4
No	2	5.6
Total	36	100
Are you involved in pediatrics imaging in the Radiology Department?		
Yes	34	94.4
No	2	5.6
Total	36	100
Is pediatric imaging a recognized sub-specialty in your department?		
Yes	13	36.1
No	23	63.9
Total	36	100
Is there any standard protocol for examining children with NAI in your department?		
Yes	9	25.0
No	27	75.0
Total	36	100
Is Skeletal survey used as the standard protocol for imaging children with NAI?		
Yes	23	63.9
No	13	36.1
Total	36	100
There is no need for sub-specialize in pediatric imaging as every radiographer should be able to handle pediatric cases.		
Strongly agree	3	8.3
Agree	5	13.9
Strongly disagree	16	44.4
Disagree	12	33.3
Total	36	100
Do you have sub-specialty training in Pediatric imaging?		
Yes	5	13.9
No	31	86.1
Total	36	100
What level of sub-specialty training do you have?		
Postgraduate certificate	2	5.6
Conference/workshop (CPD)	3	8.4
In-house seminar	31	86.1
Total	36	100
Is it advisable and economical to use a single film to image the entire baby, to avoid multiple exposures during skeletal survey?		
Strongly agree	2	5.6

Agree	11	30.6
Strongly disagree	6	16.7
Disagree	17	47.2
Total	36	100
What is the equipment used in imaging children with suspected NAI in your department?		
Conventional Radiography	23	63.9
Digital radiography system	3	8.3
Computed tomography (CT)	2	5.6
Ultrasound	8	22.2
Total	36	100

Table 3: Practice of Imaging Children with Non-Accidental Injury (NAI)

Item	Frequency	Percentage
Type of examination commonly requested for NAI		
Lower extremities	6	16.7
Upper extremities	5	13.9
Skull	3	8.3
Skeletal survey	22	61.1
Total	36	100
Commonest finding in children presenting with NAI		
Fracture	21	58.3
Abusive head trauma	4	11.1
Bruises	4	11.1
Burns	3	8.3
Birth injuries	2	5.6
Lung infection	6	16.7
Total	36	100
What projections are used to best demonstrate fracture of the spine during follow-up?		
AP projection	6	16.7
Lateral projection	19	52.8
PA projection	3	8.3
Oblique projection	8	22.2
Total	36	100
What projections are used to demonstrate fractures in the appendicular skeleton during follow-up?		
AP projection	14	38.9
PA projection	9	25
Lateral projection	9	25
Oblique projection	4	11.1
Total	36	100
What projections are used to demonstrate fracture of the Skull during follow-up?		
AP + Lateral projection	19	52.7
PA + Lateral projection	9	25.0
PA + Lateral + Townes projection	8	22.2
Total	36	100
What are the common challenges of imaging children with suspected NAI?		
The culture and traditions of the people	9	25.0
Unwillingness and poor cooperation from the healthcare team	6	16.7
Lack of strong legislation against the perpetrators	6	16.7
Lack of functional social care/child protection services within the community	5	13.9
Lack of immobilization devices and dedicated pediatric imaging facility	10	27.6
Total	36	100

Discussion

Radiographers are among the first-line caregivers in a hospital setting; hence they play a pivotal role in identifying suspected cases of NAI in children (12). The imaging's role is not only in detecting radiological findings, but also in differentiating these findings from normal variants and other conditions, determining the age of fracture, and suggesting the mechanism of injury (3). The inability to diagnose and report NAI carries a significant risk for morbidity, particularly in non-ambulatory and nonverbal children (19, 20).

Participants in this study demonstrated good knowledge and awareness of imaging children with non-accidental injuries. The majority of participants were involved in imaging children presenting with suspected non-accidental injury. Similar findings were reported by the previous studies that found good knowledge of NAI among radiographers (12,14,21,22). Good knowledge based on evidence best practices underpins the practice of radiography which enables radiographers to competently deliver quality radiography services. The majority of the respondent also agreed that history and clinical examination supplement radiological investigation. This agrees with the recommendations by Nguyen (3) where a detailed history and good clinical/physical examination could be vital in identifying occult fractures. Only a few of the respondents have a sub-specialization in pediatric imaging; however, most of the participants recognized it as a sub-specialty. Previous studies (21, 23-26), also reported a lack of formal education and training in pediatric imaging. However, a few respondents claimed there was no need to sub-specialize in pediatric imaging as every radiographer should be able to demonstrate requested radiographic projections. Increased education (sub-specialization) and optimized clinical and radiological protocols are empirical approaches to improving knowledge and diagnosis of children presenting with cases of suspected NAI (3,25). Children are unique sets of individuals presenting with peculiar needs that require special attention, knowledge and skill to adequately attend to their needs thus the place of further education (sub-specialization) cannot be over-emphasized (27).

Respondents in this study attended to several children weekly presenting with cases of suspected NAI. The commonly requested and performed imaging examinations for children with suspected NAI in this study was skeletal survey. This was in line with the recommendations by the American College of Radiology, the Society for Pediatric Radiology (ACR-SPR), the Royal College of Radiologists, the Royal College of Pediatrics and Child Health (RCR-RCPCH) (28), for imaging children with suspected NAI. A skeletal survey is a series of systematically performed high-quality radiographs demonstrating the entire skeleton and is routine in the assessment of children 2 years and below (3,10,20,29,30). Skeletal surveys can identify latent fractures, and other underlying bony pathologies and aid in fracture dating (3,31). The skeletal surveys are performed using optimally high-quality imaging systems, and strict protocols, with good attention to accurate patient positioning, among others to acquire high-quality images sufficient to depict subtle fractures and keep radiation dose to patient as low as reasonably achievable (10,17,32). The American Academy of Pediatrics (AAP) recommends a repeat of the skeletal survey after 7-10 days after sustaining an injury to reveal the healing of missed fractures during the initial examination (33).

The bone was the common organ of interest in imaging children presenting with suspected NAI, and that fracture was the commonest finding in this study. Previous studies (12,34) also reported similar findings. Fractures are generally the second most common finding in cases of children presenting with suspected NAI after bruises. Fractures can occur in any part of the skeletal system (29,30, 35-38). Abusive fractures are more common in children below 2 years of age (38). The suspicion of NAI increases when findings are not in line with the caregiver’s history and the child’s developmental stage and when concealed fractures are discovered (36). Conventional radiography and ultrasound were the major imaging modalities used in the imaging evaluation of suspected cases of children with NAI, for identification and management of suspected child abuse both in identifying new cases as well as work-up cases of suspected NAI, in this study. Previous studies (3,10,11,29) reported similar findings. Other imaging modalities like computed tomography (CT) and magnetic resonance imaging (MRI) were also used in imaging children presenting with cases of suspected NAI in this study. However, this was not extensively used as plain radiography, followed by ultrasound in our environment. This could perhaps be due to the availability and affordability of plain radiography and ultrasound imaging compared to CT and MRI which may not be readily available and even affordable for every patient. In similar studies (12,13,17,30,31), different imaging modalities like ultrasound, CT, and MRI, among others were used in imaging children presenting with suspected cases of NAI.

In this study, lateral projections, PA and oblique projections were commonly used during follow-up cases of children with NAI. Several studies on Imaging children with suspected NAI recommend performing a chest radiograph (oblique projections) to identify healing of fractured ribs, projections of the skull, pelvis, and lateral projections of the spines (30,31,39).

It is also important to note that the images for children with suspected NAI should be properly annotated with; name, age, date of examination, patient identification number, hospital number, and anatomical maker, among others for proper identification and possible follow-up imaging requirements or in cases where the images may be used as evidence of abuse in a court of law (17, 38,40).

Only a few of the radiographers in this study had sub-specialty training in pediatric imaging, with a handful having updated their knowledge through in-house seminars and workshops to keep abreast with the current realities and challenges in imaging children with NAI. Similar findings were reported in previous studies (41-43). Good knowledge of clinical and radiological manifestations of children presenting with cases of suspected abuse, good communication skill, and an understanding of the social and legal framework are very essential to the radiographer for the delivery of quality imaging service (41,42).

The majority of the respondents identified the lack of strong legislation and domestication of child protection laws in our society as the major challenges experienced in imaging children with suspected NAI. Nigeria ratified the United Nations Convention on the child right act in 1991, and in 2003, Nigeria enacted and adopted to be implemented with the 1989 Convention on the Rights of the Child and the 1990 African Union Charter on the Rights and Welfare of the Child (44). Several states in Nigeria have domesticated the Act, while several others have not, including Borno state, this is why the implementation of the rights of the child is limited in several states due to the lack of domestication of the child's right act (43,45-47).

Participants in this study also identified the lack of cooperation from the children, and the lack of pediatric facilities and immobilization devices as challenges during imaging children, especially those presenting with cases of suspected NAI. Previous studies (43,48) also reported several challenges encountered during imaging children like anxiety, crying, movement, and phobia of a strange environments, among others. Children are unique and present a conundrum of choices where the use of dedicated equipment that is easy to manipulate while allowing for fast acquisition of images of diagnostic quality, the environment must be captivating to capture their attention and make them calm, and the provisions of toys, murals and stencils can go a long way in helping relax the child during imaging examinations (43).

Participants also identified several cultural practices and traditions of the community as the major challenge in imaging children with suspected cases of NAI. Practices like, corporal punishment or harsh verbal abuse, child apprenticeship, and child labour may be tolerable in one culture but considered abuse in another culture. In some traditional practices, the male folks have an overbearing spousal control, this predisposes women and children to very harsh conditions (49). Domesticating the child rights act in every state in Nigeria with clear and implementable sanctions will help to reduce the spade of child abuse in Nigeria. Adults who were victims of childhood abuse are likely to be depressed, have suicidal tendencies, get involved in substance abuse, have interpersonal problems, and academic and vocational difficulties among others, and are likely to be abusive parents themselves (47, 50-54). Abused children suffer injuries, neurologic deficits, psychological disorders, learning difficulties, conduct disorders and even death (54)

This study is, however, limited in its sample size and also, there is the possibility of reporting bias from the participants during filling out the questionnaire. We hope that subsequent studies will try to overcome these challenges.

Conclusion

Radiographers in this study have good knowledge about NAI in children and are involved in imaging children with suspected cases of non-accidental injury. It is evident from the results of this study that NAI among children occurs in our environment and a majority of these are underreported and may even go unnoticed. Having adequate knowledge of clinical and radiologic manifestations of NAI in children will enable the radiographer to deliver evidence-based practice in line with the international best practice.

Thus, the need for encouragement, training and retraining of radiographers in pediatric imaging.

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All the authors contributed to the conceptualization, design, data analysis, drafting, revising, and approval of the final manuscript.

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QUALITY ASSURANCE OF PERSONAL PROTECTIVE APPAREL AT TERTIARY HOSPITALS IN YOLA, ADAMAWA STATE

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ABSTRACT

Background: Exposure to ionizing radiations is hazardous to radiological workers, patient's relatives and patients. The effect may be stochastic or deterministic. Protective apparel keeps the radiation dose received by hospital workers, patients and patient relatives as low as reasonable achievable (ALARA) under normal working conditions. Protective apparels are frequently mishandled in the diagnostic room after use leading to damage.

Objective: This study aimed at assessing integrity of the protective apparel used at the radiology department of a tertiary health institution in Adamawa State of Nigeria.

Methods: From three different hospitals in Yola, 26 pieces of protective apparels were identified, inspected and classified by the hospital, type, manufacturer's name, years it had been used, and the thickness of the lead. With 17 x 14-inch cassette two exposures were made on each the garment with 70 kVp and 10 mAs with a film focal distance (FFD) of 100cm with a conventional x-ray unit..

Results: The result showed 12 (46.0 %) of the protective apparel studied were defective with split 5 (42.0%), crack 4(33.0%) and hole 3(25.0%) as the most common defect. Correlation of the apparels age and the number of defective protective apparels were statistically not significant (p = 0.166).

Conclusion: In order ensure protective garments provide the best protection possible; there is a need for proper storage and regular quality assurance on the apparels in the radiology departments to ensure radiation protection..

Keywords: Apparel, Integrity, Lead Apron, protection, quality Assurance

Introduction

Since the discovery of X-rays by Wilhelm Conrad Roentgen in 1895, x-rays have been used for both the diagnosis and treatment of patients [1]. Exposure to x-rays and other ionizing radiation is hazardous to the public, radiological workers, patients' relatives, and patients [2]. The effect may be stochastic, in which the probability of occurrence of such effects begins at any given dose and increases as the dose increases, or deterministic, in which the effect begins only when the absorbed dose reaches a certain threshold level, and its severity increases as the dose increases [3]. Protective apparel provides valuable aids in keeping the radiation dose received by hospital workers and patient relatives under normal working conditions as low as reasonably achievable [4].

Personnel, patients, and occasionally patients relatives use personal protective apparel, most commonly lead aprons, gonadal shields, and thyroid shields, to protect themselves from unnecessary ionizing radiation exposure during diagnostic radiological procedures [5, 6]. Protective apparel comes in different forms, shapes, sizes, and thicknesses, they attenuate 90% - 97% of incident scattered radiation at an energy range of 60 kVp to 120 kVp depending on the thickness [5, 7, 10].

Personal protective apparel are frequently mishandled in the diagnostic room after use. Most radiology departments have hangers and racks for proper hanging after use; however, some radiation workers leave them on the x-ray machine table, lead screens (protective barriers), and even on the floor after use when they are contaminated with contrast agent or body fluid during special procedures. Most personnel go for the physically heavy lead apron; however, the ability to protect individuals from the effects of ionizing radiation is not just the weight but also the integrity of the lead in it. Hence the need to assess the integrity of protective apparel at tertiary hospitals in Yola, Adamawa state..

Methods:

A cross-sectional, prospective study design was used for the study. A floor-mounted x-ray unit with an energy output of 125 kVp and a tube current of 500 mA was used to obtain the exposures. While a Konica Minolta computed radiography (CR) system, and a 43 cm x 35 cm phosphor plate cassette were used as image recording systems.

A total of 26 pieces of protective apparel from three tertiary hospitals in Yola were studied, with each apparel being identified by the hospital from which it was obtained, the type, the manufacturer's name, the approximate number of years it had been used, and the thickness. The names of the hospitals were coded H_1, H_2, and H_3 for anonymity.

The outer and inner coverings of the personal protective apparel were systemically subjected to a visual inspection and palpation to check for apparent deterioration, as well as any cracks or evidence of seam separation or sagging. Each protective apparel was spread flat on the tabletop and exposures were made at 70 kVp and 10 mAs with a film focal distance (FFD) of 100 cm, adopted from the University of Iowa Hospital & clinics policy and diagnostics manual [11]. Two exposures were made using a 43 cm x 35 cm Phosphor plate cassette placed in the Bucky tray to cover the upper and lower regions of the apron, and the image was processed using the Konica Computed Radiography system. Measurements of the sizes of the defects was taken using measuring tools found on the CR monitor screen. Data relating to each lead apron were recorded using a data capture sheet, and the images were saved on a CD for review. Data were uploaded to Mendeley and the doi were obtained (doi: 10.17632/23z7hhfp6t.1).

Quantitative criteria for rejection of protective apparel as recommended by Lambert and Mckeon that protective clothing be replaced if defects of greater than 15 mm^2 are identified near critical organs (e.g., breast, gonads, etc.) or if defects greater than 670 mm^2 are identified over non-critical areas (around seams or in overlapping areas). For thyroid collars, if defects greater than 11 mm^2 should be replaced [12].

Data analysis was done using the Statistical Package for Social Sciences (SPSS) Version 16.0. Statistical significance was taken at 0.05% (i.e., P = 0.05). Results were presented using statistical tools such as tables, bar charts, and graphs and described using descriptive statistics of frequency and percentages

Results:

A total number of 26 Personal protective apparel, comprising 17 lead aprons, 3 patient covers, and 6 gonadal shields, were examined, as shown in Table 1. The hospital distribution as shown was: 17 from H_1, 3 from H_2, and 6 from H_3. Most of the personal protective apparel had a lead thickness of 0.5 mm, as shown in Table 2. As shown in table 3 and figure 1, the most common defects on the protective apparel were split 5 (42.0%), crack 4 (33.0%), and hole 3(25.0%). Out of 12 defective apparel, 11 (92%) met rejection criteria (defects near critical organs with sizes of > 15 mm^2), and 1(8%) was accepted. Although visual inspection had suggested some of the protective apparel should be replaced beforehand, the radiograph confirmed the extent of the defects observed. About 83.0% of defects were also noticed in pprotective apparel with no manufacturer's names (Figure 2). The period during which these aprons had been used varied, although there was no documentation on the date of the first usage; however, the manufacturing date found on the lead apron was between 1998 and 2019, with an average age of 8.4 years. The results were statistically insignificant, with a low negative correlation between age of the protective apparel and defect incident: r (24) = - 0.280 = 0.166, with age explaining 7.8% variation in defect incident (table 4)

Table 1: Distribution of different types of personal protective apparel by hospital

Hospitals	Personal protective shield			Total
	Lead apron	Patient cover	Gonadal shield	
H_1	11 (64.7%)	3 (100%)	3 (50.0%)	17 (11.5%)
H_2	3 (17.6%)	0 (0.0%)	0 (0.0%)	3 (11.5%)
H_3	3 (17.6%)	0 (0.0%)	3 (50.0%)	6 (23.1%)
Total	17(100.0%)	3(100.0%)	6(100.0%)	26 (100.0%)

Table 2: Distribution of lead equivalent of personal protective apparel

Protective shield	Thickness(mm)				Total
	0.25	0.3	0.35	0.5	
Lead apron	1(50.0%)	4(80.0)	0 (0.0%)	12(66.7%)	17(65.0%)
Patient cover	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (16.7%)	3(11.5%)
Gonadal shield	1(50.0%)	1(20.0%)	1(100%)	3 (16.7%)	6(23.1%)
Total	2(100%)	5(100%)	1(100%)	18(100%)	26(100%)

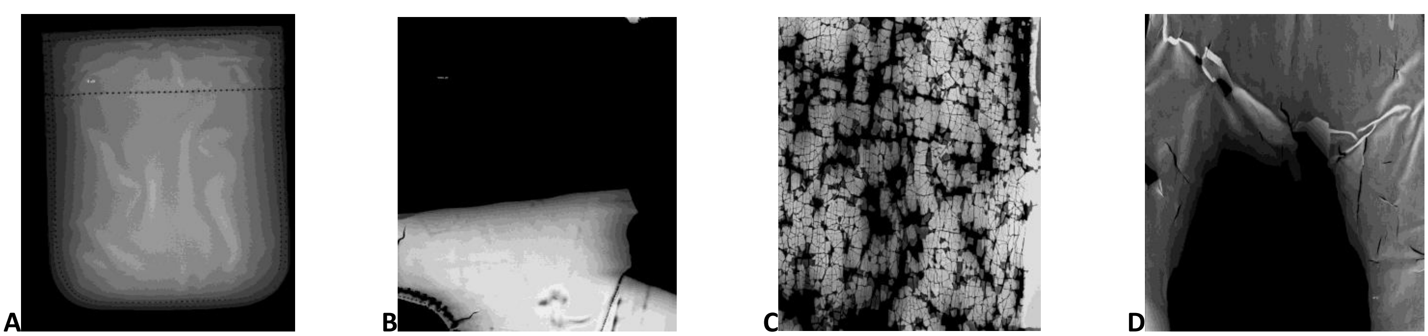

Figure 1: Radiographic images of the protective shield showing different types of defects. Free from defects (A), Splits (sagging), cracks, tears, and holes (B, C, and D)

Type of defect	Accepted	Rejected	Total
Crack	1 (100.0%)	3 (27.3%)	4 (33.3%)
Hole	0 (0.0%)	3 (27.3%)	3 (25.0%)
Split	0 (0.0%)	5 (45.5%)	5 (41.7%)
Total	1 (100%)	11 (100%)	12 (100%)

		Age	Defect
Age	Pearson Correlation	1	-.280
	Sig. (2-tailed)		.166
	N	26	26
Defect	Pearson Correlation	-.280	1
	Sig. (2-tailed)	.166	
	N	26	26

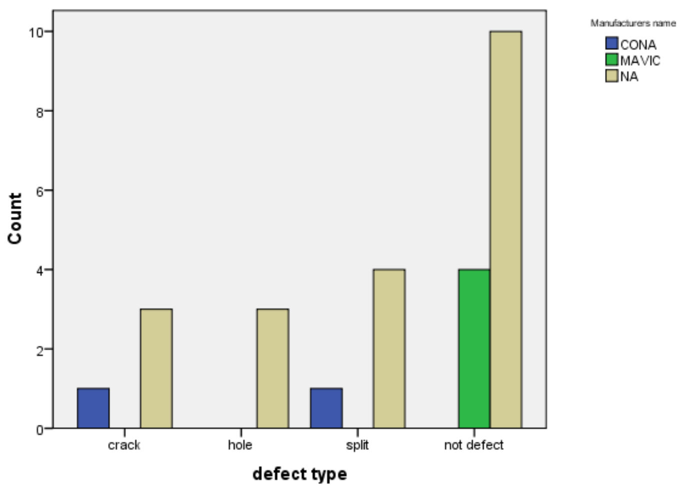

Figure 2: Personal protective apparel by manufacturer names and number of defects

Discussion:

The protective apparel is used to protect users from secondary radiation exposure, these garments are subject to significant wear and tear, especially in busy X-ray facilities, its lifespan ranges from roughly 5 to 10 years, depending on the usage and how it is taken care of [12, 19, 21]. Protective garments, like any other product, should be tested on receipt and should be visually inspected at least every 6 months and fluoroscopically or radiographically inspected at least once every 24 months for the effectiveness of radiation protection [12].

Following the assessment of 26 protective apparel, the results from this study show that up to 12 (46.0 %) of the protective apparel studied were defective, which is higher than the results obtained by Nkubuli *et al.*, [13] and Anas *et al.*, [14] which reported 34.0 %, and 38.8% respectively. However, the findings of this study proved to be lesser as compared to the results reported by Chiegwu *et al.*, [15] and Oyar and Kislaliglu, [3] which were 55.6% and 68.2% respectively.

The study also revealed that the most common type of defect is splits (separation) which account for 42.0% which differs from the results obtained in other studies where cracks were the major defects, accounting for 44% [16], 60% [15], 56.25% [13], and 70% [17]. The protective apparel's integrity deteriorates as it ages; however, the level of damage observed on the aprons was not necessarily dependent on the age of the apron but may also be attributed to poor handling by the users, as folding and dropping of aprons were observed in some of the hospitals, which could be one of the major causes of rips, cracks, and holes in the protective apparel. Similarly, the correlation between the apparel age and the number of defective apparel was not significant ($p = 0.166$).

Some of the defective areas in the lead aprons were close to the lower part of the aprons that is supposed to protect the sensitive organs like gonads with a high tissue weighting factor, as classified by Oppliger-Schäfer and Roser, any major defects on protective layers at relevant locations should be withdrawn or repaired immediately [18]. About 11 (92%) of the defects observed exceeded the maximum area 15 mm^2 and 10 cm^2 for rejection and replacement as recommended by Lambert & McKeon [12] and Duran & Phillips [20], as well as Sam & Pillay [4], which states that the maximum tolerable length of a defect on a whole-body garment with the lead equivalent of 0.25 mm, 0.35 mm, and 0.5 mm should not exceed 5.4 cm, 5.6 cm, and 5.9 cm respectively. Furthermore, about 83.0% of defects were noticed in protective apparel with no manufacturer's name, which is in tandem with what was recorded by Ukpong [16], who reported 81%

of defects found on the apron with no manufacturer's name.

It has been noted that most of the defects found in this study are in agreement with a study conducted by Bawazeer [21], which stated that body aprons were more likely to damage than other protective garments; this could be a result of frequent usage. It is recommended that X-ray racks and hangers be used to safely hold the protective garment when not in use [22], and protective garments should be checked for integrity annually [23]. As a result, we recommend that protective apparel with significant defects be replaced, and new apparel should be tested for integrity upon receipt (an "acceptance test") and management should avoid the procurement of low-quality protective apparel because such apparel is incapable of providing the needed radiation protection to the users and are prone to defect before their expected life span. Management should involve or seek advice from experts and end users when procuring.

In conclusion, the research revealed that a significant number of the protective garments were defective, with spits, cracks, and holes as the major defects observed, which are indicative of improper care of the protective apparel. To ensure protective garments provide the best possible protection, there is a need for proper handling and regular quality assurance on the apparel in the radiology departments to ensure radiation protection. The first step towards this is to ensure that the protective apparel is tested for radiation protection efficiency before purchase or receipt as recommended by regulatory agencies.

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